- PATENT -

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Buljore et al.	EXAMINER:	Nguyen, Leon Viet Q.
SERIAL NO.:	10/509,766	GROUP:	2635
FILED:	09/28/2004	CASE NO.:	CR00556P

TITLED: Wireless Communication Using Multi-Transmit-Multi-Receive Antenna Arrays

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APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner of Patents
P.O. Box 1450
Alexandria, Va. 22313-1450

Commissioner:

The appellants hereby respectfully submit the following Appeal Brief in response to a Final Office Action dated January 19, 2007, with a Notice of Appeal filed herewith.

1. REAL PARTY IN INTEREST

The real party in interest in this appeal is Motorola, Inc., a Delaware corporation having a primary place of business in Schaumburg, Illinois.

2. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences that will directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal.

3. STATUS OF CLAIMS

This is an appeal from a Final Office Action, dated January 19, 2007. Claims 1-4 and 7 are pending and presently stand once and finally rejected and constitute the subject matter of this appeal. Claims 1-4 and 7 are appealed.

In a First Office Action dated November 27, 2006, the Examiner rejected Claims 1-2 and 4-6 under 35 U.S.C. §102(b) as being anticipated by Hottinen et al (WO 01/69814 A1), and rejected Claim 3 under 35 U.S.C. §103(a) as being unpatentable over Hottinen et al (WO 01/69814 A1) in view of Raleigh (US 6,377,631). In an amendment and response dated December 6, 2006, the appellants replied to the first Office Action with an amendment to claims 1 and 3 and the addition of claim 7.

In a Final Office Action dated January 19, 2007, the Examiner rejected Claims 1, 2, 4 and 7 under 35 U.S.C. §102(b) as being anticipated by Hottinen et al (WO 01/69814 A1), and rejected Claim 3 under 35 U.S.C. §103(a) as being unpatentable over Hottinen et al (WO 01/69814 A1) in view of Raleigh (US 6,377,631), for the same reasons recited in the First Office Action. Appellant provided no further amendment or response.

The pending claims 1-4 and 7 filed and entered before the Final Office Action are reproduced below.

4. STATUS OF AMENDMENTS

An amendment and response to the First Office Action was filed on December 6, 2006, and is currently pending. The appellants received a Final Rejection, dated January 19, 2007 rejecting appellant's arguments and maintaining the First Office Action.

5. SUMMARY OF CLAIMED SUBJECT MATTER

Referring to FIG. 2, the subject matter relates to a method of, and apparatus for, wireless communication using multi-transmit multi-receive antenna arrays. A plurality of distinct data streams (x_1, x_2) are transmitted from the transmit antenna array to the receive antenna array and the data streams are weighted by respective complex weighting matrices before being applied to the transmit antenna array. The distinct data streams are separated and estimated at the receiver. The distinct data streams (x_1, x_G) are applied to respective sub-groups of the transmit antenna elements at least one of which comprises a plurality of the transmit antenna elements. Each of the sub-groups comprise at least N_d transmit antenna elements, where M is greater than or equal to (N/N_d). The complex weighting matrices (v_1 to v_n) are functions of the respective transmission channels (h_{ij}) of the data streams (x_1, to x_G) including the respective sub-groups of transmit antenna elements.

N_d is preferably greater than or equal to two. Each of the complex weighting matrices is calculated to be substantially equal to the eigenvector corresponding to the largest eigenvalue of the matrix $\mathbf{H}^H\mathbf{H}$, where $\mathbf{H}$ is the matrix of the equivalent channel including the respective sub-groups of transmit antenna elements seen by the corresponding data stream. $\mathbf{H}^H$ is the Hermitian transform of the matrix $\mathbf{H}$. The number of the transmit antenna elements in each of the sub-groups is preferably re-configurable during operation as a function of channel conditions.

In particular, Claim 1 provides a method of closed-loop multi-stream wireless communication between transmitter means (1 in Fig. 2) comprising a transmit antenna array of a plurality of N transmit antenna elements (subgroups 6, 7 in Fig. 2, see page 7 lines 11-12) and receiver means (3 in Fig. 2) comprising a receive antenna array of a plurality of M receive antenna elements (4 in Fig. 2), wherein a plurality of distinct data streams (x_1, x_2) (see page 7 lines 12-14) are transmitted from said transmit antenna array

(6, 7 in Fig. 2) to said receive antenna array (4 in Fig. 2) and said data streams are weighted by respective complex weighting matrices before being applied to said transmit antenna array (page 7 lines 14-18), said distinct data streams being separated and estimated at said receiver means (page 7 lines 18-20). The method includes a step of applying said distinct data streams (x_1, x_G) to respective sub-groups (6,7 of Fig. 2 and page 7 lines 14-18) of said transmit antenna elements at least one of which comprises a plurality of said transmit antenna elements, each of said sub-groups (6,7 of Fig. 2) comprising at least N_d transmit antenna elements, where M is greater than or equal to (N/N_d) (page 7 line 21, page 9 lines 6-9, and page 10 lines 21-27), said complex weighting matrices (v_1 to v_n) being functions of the respective transmission channels (h_{ij}) of said data streams (x_1, to x_G) (page 8 lines 1-3 and Equation 2) between each of the plurality of N transmit antenna elements and each of the plurality of M receive antenna elements including the respective sub-groups (6, 7 of Fig. 2) of transmit antenna elements.

Claim 7 provides an apparatus for closed-loop multi-stream wireless communication between transmitter means (1 in Fig. 2) having a transmit antenna array of a plurality of N transmit antenna elements (subgroups 6, 7 in Fig. 2, see page 7 lines 11-12), and receiver means (3 in Fig. 2) having a receive antenna array of a plurality of M receive antenna elements (4 in Fig. 2). The transmitter means is operable to transmit a plurality of distinct data streams (x_1, x_G) (see page 7 lines 12-14) from said transmit antenna array (6, 7 in Fig. 2) to said receive antenna array (4 in Fig. 2) and to weight said data streams by respective complex weighting matrices before being applied to said transmit antenna array (page 7 lines 14-18). The receiver means is operable to separate and estimate said distinct data streams (page 7 lines 18-20). The transmitter means further comprises means for applying said distinct data streams (x_1, x_G) to respective sub-groups (6,7 of Fig. 2 and page 7 lines 14-18) of said transmit antenna elements at least one of which comprises a plurality of said transmit antenna elements, each of said sub-groups (6,7 of Fig. 2) comprising at least N_d transmit antenna elements, where M is greater than or equal to (N/N_d) (page 7 line 21, page 9 lines 6-9, and page 10 lines 21-27), said complex weighting matrices (v_1 to v_n) being functions of the respective transmission channels (h_{ij}) of said data streams (x_1, to x_G) (page 8 lines 1-3 and Equation 2) between

each of the plurality of N transmit antenna elements and each of the plurality of M receive antenna elements including the respective sub-groups (6, 7 of Fig. 2) of transmit antenna elements.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 2, 4 and 7 have been rejected under 35 U.S.C. §102(b) as being anticipated by Hottinen et al (WO 01/69814 A1).

Claim 3 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Hottinen et al (WO 01/69814 A1) in view of Raleigh (US 6,377,631).

The appellant disputes these rejections.

7. ARGUMENT

(i) Rejection under 35 U.S.C. §112, first paragraph:

None

(ii) Rejection under 35 U.S.C. §112, second paragraph:

None

(iii) Rejection under 35 U.S.C. §102:

<u>A. Rejection under 35 U.S.C. 102(b) – Hottinen et al.</u>

The Examiner rejected claims 1, 2, 4 and 7 under 35 U.S.C. §102(b) as being anticipated by Hottinen et al (WO 01/69814 A1, hereinafter “Hottinen”).

<u>Claim 1</u>

Independent claim 1 describes a receiver that comprises an antenna array having a plurality of antenna receiver elements and that the complex weighting matrices are functions of the respective transmission channels of the data streams between each of the

plurality of N transmit antenna elements and each of the plurality of M receive antenna elements.

In the Final Rejection the Examiner cited Hottinen page 1 lines 8-9 as reading on appellant's multiple receiving elements, and that since more than one element can be used in Hottinen, it is inherent that weighting matrices are a function of each additional receive element. However, appellant's reading of page 1 line 8-9 only indicate that multiple *receivers* can be used, without the mention of multiple *elements* per receiver. Appellant respectfully submits that having multiple elements per receiver in appellant's invention is handled completely differently than having one element per each receiver.

In the First Office Action the Examiner repeated the above argument as well. In addition, the Examiner failed to find a reference in Hottinen describing applying different data streams to different *subgroups* of transmitter antenna elements. Indeed, the Examiner points out that the total antenna elements described in Hottinen is two, therefore subgroups could not have been envisioned in Hottinen.

The Examiner also stated that Hottinen (page 19 lines 1-9) describes that the transmitted data streams are weighted by complex weighting matrices. However, the complex matrices described in Hottinen do not describe the matrices as being functions of transmission channels between a plurality of transmit elements and a plurality of receive elements. Instead Hottinen only refers to weighting for transmit diversity without regard for multiple receive elements, since only one receive element is used.

The Examiner also stated that Hottinen describes distinct data streams that are separated and estimated at receiver means (page 15 lines 25-32). However, appellant disagrees with this argument in that this passage merely recites that pilot signals are received as well as data signals. There is no specific *separation* needed since pilot signals are broadcast on a different channel or time, and there is no *estimation* performed at all. This is completely different from appellant's invention that receives two or more different data signals (as well as pilot signals) that require separation as estimation as recited in the claims.

Moreover, the Examiner admits that Hottinen describes a situation where M can not equal N/N_d in contrast to appellant's claimed M that can be equal to N/N_d. This is directly because Hottinen does not suggest or disclose multiple receive elements, and therefore could not have envisioned appellant's novel solution.

Therefore, appellant respectfully submits that Hottinen is missing at least the several elements discussed above.

Appellant's invention is exclusively directed to a Multi-Transmit-Multi-Receive (MTMR) diversity scheme (ref. e.g. page 3 lines 27-29 and page 2 lines 29-31). MTMR is a new technology which is currently being researched and which is considered for introduction to existing communication system. MTMR inherently relies on a plurality of both receive and transmit antennas and use cross correlation of information between signals received at a plurality of receive antenna elements to extract the data received from a plurality of transmit antennas. Hence, it is an essential feature and requirement of MTMR that a plurality of transmit and receive antenna elements are employed.

Advantageously, the present invention provides for an improved MTMR system and it is a particular object of the invention that an increase of spectral efficiency is achieved (see page 3 lines 21 to 25 and page 9 line 7). The system achieves this by using an MTMR arrangement wherein different signals are transmitted from different antenna sub-groups with signals of each antenna element being weighted in response to respective transmission channels of the data streams between each of the plurality of *N* transmit antenna elements and each of the plurality of *M* receive antenna elements. Thus, the weights are determined, not just in response to different characteristics of different transmit antenna elements, but also in response to different characteristics of different receive elements (ref. e.g. page 7 line 24 to page 9 line 5).

In contrast, it is respectfully submitted that Hottinen does not even consider MTMR systems. Rather it is respectfully submitted that Hottinen merely describes variations of conventional transmit diversity schemes wherein a signal may be transmitted with diversity for reception by a simple standard *single* antenna element of a receiver.

In particular, Hottinen merely describes a system of combining a standard closed loop transmit diversity technique (known as TxAA) with a standard open loop transmit diversity technique (known as STTD). However, the system is clearly not an MTMR system but is a pure transmit diversity scheme wherein a single receive antenna element is used (ref. FIG. 3 and the whole of the description). Thus, it is respectfully submitted that Hottinen is concerned only with a traditional transmit diversity system which has

substantially different technical characteristics, performance and problems than an MTMR system. For example, any weight calculation is performed on the basis of transmit diversity differences only, and there is no disclosure or suggestion that transmission weights of the transmitter may be adjusted in response to a diversity arrangement of a remote receiver.

Moreover, Hottinen does not include any suggestion or hint that a plurality of receive antenna elements could be used or how the system could be (and must be) modified to work in such an MTMR arrangement. Accordingly, it is respectfully submitted that Hottinen clearly fails to disclose a system in accordance with independent claims 1 and 7 and in particular fails to disclose a plurality of receive antenna elements and a determination of weights for different data streams transmitted from different antenna element subgroups being determined as a function of transmission channels to a plurality of receive antenna elements.

An objective problem solved by the present invention is that of how to provide improved spectral efficiency in an MTMR system. Hottinen does not provide a solution to this problem. It is also noted that in fact the system of Hottinen does not provide any improvement in spectral efficiency but maintains the same data rate in the same channel bandwidth (the system employs a transmit diversity block code scheme where redundant symbols are transmitted thus resulting in an unchanged information data rate). Thus, not only is Hottinen concerned with a technically substantially different communication system, Hottinen is also dealing with a different object than the present invention and cannot provide the advantages of the present invention.

Thus, it is respectfully submitted that claim 1 is patentably distinct and non-obvious over Hottinen, and is therefore allowable.

Claims 2 and 4 are dependent on amended claim 1, hereby incorporated by reference, and are deemed allowable as well for the same reasons.

<u>Claim 7</u>

Independent claim 7 includes the same recitations as detailed with respect to claim 1 above, but in apparatus form. The appellant therefore respectfully submits that all of the points raised above with respect to the claim 1 are relevant for claim 7 as well. Those points will not be repeated here, however, for the sake of brevity, but to say that claim 7 is deemed allowable as well for the same reasons.

(iv) Rejection under 35 U.S.C. §103:

B. Rejection under 35 U.S.C. 103(a) – Hottinen et al in view of Raleigh

The Examiner rejected claim 3 under 35 U.S.C. §103(a) as being unpatentable over Hottinen et al (WO 01/69814 A1) in view of Raleigh (US 6,377,631).

Claim 3 is dependent on amended claim 1, hereby incorporated by reference. The appellant therefore respectfully submits that all of the points raised above with respect to the claim 1 are relevant for claim 3 as well. Those points will not be repeated here, however, for the sake of brevity, but to say that claim 3 is deemed allowable as well for the same reasons.

Accordingly, appellant respectfully requests that the above rejections be reversed and the claims allowed.

(v) Other rejections

None.

In conclusion, and for the above reasons, the appellants respectfully submit that the rejection of Claims 1, 2, 4 and 7 under 35 U.S.C. §102(b) as being anticipated by Hottinen et al (WO 01/69814 A1), and the rejection of Claim 3 under 35 U.S.C. §103(a) as being unpatentable over Hottinen et al (WO 01/69814 A1) in view of Raleigh (US 6,377,631), are in error and should be reversed and the claims allowed.

8. CLAIMS APPENDIX

1. (previously presented) A method of closed-loop multi-stream wireless communication between transmitter means comprising a transmit antenna array of a plurality of N transmit antenna elements and receiver means comprising a receive antenna array of a plurality of M receive antenna elements, wherein a plurality of distinct data streams (x_1, x_2) are transmitted from said transmit antenna array to said receive antenna array and said data streams are weighted by respective complex weighting matrices before being applied to said transmit antenna array, said distinct data streams being separated and estimated at said receiver means, the method comprising:

   applying said distinct data streams (x_1, x_G) to respective sub-groups of said transmit antenna elements at least one of which comprises a plurality of said transmit antenna elements, each of said sub-groups comprising at least N_d transmit antenna elements, where M is greater than or equal to (N/N_d), said complex weighting matrices (v_1 to v_n) being functions of the respective transmission channels (h_{ij}) of said data streams (x_1, to x_G) between each of the plurality of N transmit antenna elements and each of the plurality of M receive antenna elements including the respective sub-groups of transmit antenna elements.

2. (original) A method as claimed in claim 1, wherein N_d is greater than or equal to two.

3. (previously presented) A method as claimed in claim 1, wherein each of said complex weighting matrices is calculated to be substantially equal to the eigenvector corresponding to the largest eigenvalue of the matrix $\mathbf{H}^H\mathbf{H}$, where $\mathbf{H}$ is the matrix of the equivalent channel including the respective sub-groups of transmit antenna elements seen by the corresponding data stream and $\mathbf{H}^H$ is the Hermitian transform of the matrix $\mathbf{H}$.

4. (previously presented) A method as claimed in claim 1, wherein the number of said transmit antenna elements in each of said sub-groups is re-configurable during operation.

5. (canceled).

6. (canceled).

7. (previously presented) An apparatus for closed-loop multi-stream wireless communication between transmitter means having a transmit antenna array of a plurality of *N* transmit antenna elements, and receiver means having a receive antenna array of a plurality of *M* receive antenna elements, wherein:

   the transmitter means is operable to transmit a plurality of distinct data streams (x_1, x_G) from said transmit antenna array to said receive antenna array and to weight said data streams by respective complex weighting matrices before being applied to said transmit antenna array,

   the receiver means is operable to separate and estimate said distinct data streams, and

   the transmitter means further comprises means for applying said distinct data streams (x_1, x_G) to respective sub-groups of said transmit antenna elements at least one of which comprises a plurality of said transmit antenna elements, each of said sub-groups comprising at least N_d transmit antenna elements, where M is greater than or equal to (N/N_d), said complex weighting matrices (v_1 *to* v_n) being functions of the respective transmission channels (h_{ij}) of said data streams (x_1, *to* x_G) between each of the plurality of *N* transmit antenna elements and each of the plurality of *M* receive antenna elements including the respective sub-groups of transmit antenna elements.

9. EVIDENCE APPENDIX

Not applicable

10. RELATED PROCEEDINGS APPENDIX

Not applicable

Respectfully submitted,

Buljore et al.

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